CLAIMS

What is claimed is:

1. A microfluidic flow guiding structure comprising:

(a) a base having a surface;

(b) a cover having a surface facing the base surface and spaced from the base surface by 1000 μm or less;

(c) adjacent facing regions on the base surface and cover surface defining a flow path from a source position to a destination position on the base surface and cover surface, at least a region on each of the base surface and cover surface being wettable by and having a wetting angle of less than 90° with respect to a selected liquid, the wettable region on at least one of the base surface and cover surface formed as a flow guiding stripe and a region adjacent to the guiding stripe on the at least one of the base surface and cover surface being non-wettable by and having a wetting angle of greater than 90° with respect to the selected liquid.

2. The microfluidic flow guiding structure of Claim 1 wherein each of the base surface and cover surface have a wettable flow guiding stripe thereon and a non-wettable region adjacent to the flow guiding stripe.

3. The microfluidic flow guiding structure of Claim 1 wherein the selected liquid is water and each guiding stripe is wettable by water and the region adjacent to each guiding stripe is non-wettable by water.

4. The microfluidic flow guiding structure of Claim 1 wherein the base and cover are formed of a material which has a wetting angle less than 90° with respect to the selected liquid, and wherein each guiding stripe is defined on an exposed surface of the material forming the base or cover, and wherein the regions adjacent to each guiding stripe is formed of a layer of material differing from the material of the base or cover and that has a wetting angle with respect to the selected liquid of greater than 90°.

5. The microfluidic flow guiding structure of Claim 4 wherein the layer of material in the region adjacent to each guiding stripe is formed of a self-assembled monolayer material.

6. The microfluidic flow guiding structure of Claim 5 wherein the layer of material is a self-assembled monolayer of a trichlorosilane and the material of the base and cover is silicate glass.

7. The microfluidic flow guiding structure of Claim 6 wherein the trichlorosilane is selected from the group consisting of octadecyltrichlorosilane and heptadecafluoro-1,1,2,2-tetrahydrodecyltrichlorosilane.

8. The microfluidic flow guiding structure of Claim 1 wherein there are regions on the base surface and the facing cover surface defining at least two parallel flow guiding stripes on the base and cover surfaces that are wettable by the selected liquid which are separated by a region that is not wettable by the selected liquid.

9. The microfluidic flow guiding structure of Claim 1 wherein each wettable flow guiding stripe has regions adjacent thereto on two sides of the guiding stripes that are non-wettable by the selected liquid.

10. The microfluidic flow guiding structure of Claim 1 wherein there is a region on one side of each wettable flow guiding stripe that is non-wettable by the selected liquid and wherein there is a vertical sidewall extending between the base and cover surfaces at another side of the stripe.

11. The microfluidic flow guiding structure of Claim 10 wherein the vertical sidewall is formed of a material that is wettable by the selected liquid.

12. The microfluidic flow guiding structure of Claim 1 further including means for pumping liquid onto the flow guiding stripe region.

13. The microfluidic flow guiding structure of Claim 12 wherein the means for pumping liquid comprises a syringe pump.

14. The microfluidic flow guiding structure of Claim 1 wherein the base includes a main channel having a bottom wall and two sidewalls, the cover extending over the main channel, a flow guiding stripe on the base formed on the bottom wall of the main channel and an adjacent flow guiding stripe of the cover formed on the cover surface facing the bottom wall of the main channel, and the non-wettable region adjacent to the flow guiding stripe on the base also formed on the bottom wall of the main channel.

15. The microfluidic flow guiding structure of Claim 14 further including at least one side channel having a bottom wall and two sidewalls, the cover extending over the at least one side channel and having a surface spaced from and facing the bottom wall of the side channel, the at least one side channel intersecting the main channel, a flow guiding stripe formed on the bottom wall of the side channel and an adjacent facing flow guiding stripe formed on the cover surface that are wettable by the selected liquid, and a region on the bottom wall of the side channel and on the facing cover surface adjacent to the flow guiding stripes in the side channel being non-wettable by the selected liquid, the flow guiding stripes in the side channel intersecting and joining the flow guiding stripes in the main channel.

16. The microfluidic flow guiding structure of Claim 15 wherein there are two side channels each having bottom walls and two sidewalls and facing surfaces of the cover spaced from the bottom walls of the side channels, the side channels intersecting the main channel on opposite sides of the main channel, wherein there are two flow guiding stripes formed on the bottom wall of the main channel and two facing flow guiding stripes formed on the cover surface that are each separated by a region that is not wettable by the selected liquid, and wherein the flow guiding stripes of one of the side channels is joined to a first of the flow

guiding stripes in the main channel and the flow guiding stripes of the other side channel are joined to a second of the flow guiding stripes in the main channel.

17. The microfluidic flow guiding structure of Claim 16 wherein the width of the main channel between the sidewalls of the main channel and the height of the main channel between the bottom wall and cover surface are less than 1,000 μm.

18. The microfluidic flow guiding structure of Claim 17 wherein the base and cover are formed of a silicate glass.

19. The microfluidic flow guiding structure of Claim 1 including a barrier found between flow guiding stripes form on the base and cover surface to block flow thereon below a pressure level above which liquid on the guiding stripes will flow around the barrier.

20. The microfluidic flow guiding structure of Claim 19 wherein the barrier is formed of hydrogel that reacts to selected conditions in the selected liquid to swell to block the flow of liquid.

21. A microfluidic flow guiding structure comprising:

(a) a base having a surface;

(b) a cover having a surface facing the base surface and spaced from the base surface;

(c) adjacent facing regions on the base surface and cover surface defining a flow path from a source position to a destination position on the base surface and cover surface, one region on each of the base surface and cover surface formed as a flow guiding stripe and being wettable by and having a wetting angle of less than 90° with respect to a selected liquid, and a region adjacent to the guiding stripe on each of the base surface and cover surface being non-wettable by and having a wetting angle of greater than 90° with respect to the selected liquid.

22. The microfluidic flow guiding structure of Claim 21 wherein the cover surface is spaced from the base surface by 1000 μm or less.

23. The microfluidic flow guiding structure of Claim 21 wherein the selected liquid is water and the guiding stripes on the base surface and the cover surfaces are wettable by water and the regions adjacent to the guiding stripes are non-wettable by water.

24. The microfluidic flow guiding structure of Claim 21 wherein the base and cover are formed of a material which has a wetting angle less than 90° with respect to the selected liquid, and wherein the guiding stripes are defined on the surfaces of the base and cover as an exposed surface of the material forming the base and cover, and wherein the regions adjacent to the guiding stripes are formed of a layer of material differing from the material of the base or cover and that has a wetting angle with respect to the selected liquid of greater than 90°.

25. The microfluidic flow guiding structure of Claim 24 wherein the layer of material in the regions adjacent to the guiding stripes is formed of a self-assembled monolayer material.

26. The microfluidic flow guiding structure of Claim 25 wherein the layer of material is a self-assembled monolayer of a trichlorosilane and the material of the base and cover is silicate glass.

27. The microfluidic flow guiding structure of Claim 26 wherein the trichlorosilane is selected from the group consisting of octadecyltrichlorosilane and heptadecafluoro-1,1,2,2-tetrahydrodecyltrichlorosilane.

28. The microfluidic flow guiding structure of Claim 21 wherein there are regions on the base surface and the facing cover surface defining at least two parallel flow guiding stripes on the base and cover surfaces that are wettable by the selected liquid which are separated by a region that is not wettable by the selected liquid.

29. The microfluidic flow guiding structure of Claim 21 wherein the wettable flow guiding stripes on the base and cover surfaces have regions adjacent thereto on two sides of the guiding stripes that are non-wettable by the selected liquid.

30. The microfluidic flow guiding structure of Claim 21 wherein there is a region on one side of the wettable flow guiding stripes on the base and cover surfaces that is non-wettable by the selected liquid and wherein there is a vertical sidewall extending between the base and cover surfaces at another side of the stripes.

31. The microfluidic flow guiding structure of Claim 30 wherein the vertical sidewall is formed of a material that is wettable by the selected liquid.

32. The microfluidic flow guiding structure of Claim 31 further including means for pumping liquid onto the adjacent flow guiding stripe regions on the base and cover surfaces.

33. The microfluidic flow guiding structure of Claim 32 wherein the means for pumping liquid comprises a syringe pump.

34. The microfluidic flow guiding structure of Claim 32 including a barrier found between the guiding stripes on the base and cover to block flow thereon below a pressure level above which liquid on the guiding stripes will flow around the barrier.

35. The microfluidic flow guiding structure of Claim 34 wherein the barrier is formed of hydrogel that reacts to selected conditions in the selected liquid to swell to block the flow of liquid.

36. A method of forming a microfluidic flow guiding structure comprising:

(a) forming a channel in a base and a cover, the channel having a bottom wall and two vertical sidewalls in the base and a surface of the cover spaced

from and facing the bottom wall, the height of the channel between the bottom wall and the facing cover surface being 1,000 μm or less;

(b) injecting into the channel at least two parallel streams of liquid and flowing them together in the channel in adjacent laminar flow in contact with the bottom wall and the cover surface, one of the liquids being a solvent which does not affect the surface of the bottom wall of the channel and the cover surface and the other of the liquids being material that deposits a self-assembled monolayer onto the surface of the bottom wall of the channel and the cover surface over which the stream of liquid passes, the material of the bottom wall of the channel and of the cover surface being wettable by a selected liquid and the self-assembled monolayer deposited on the surfaces being non-wettable by the selected liquid.

37. The method of Claim 36 wherein the stream of material that deposits a self-assembled monolayer is a trichlorosilane in a solution with a solvent.

38. The method of Claim 37 wherein the stream of solvent is liquid hexadecane and wherein the stream of liquid that deposits a self-assembled monolayer is a solution of a trichlorosilane and hexadecane.

39. The method of Claim 38 wherein the trichlorosilane is selected from the group consisting of octadecyltrichlorosilane and heptadecafluoro-1,1,2,2-tetrahydrodecyltrichlorosilane.

40. The method of Claim 36 wherein the channel is a main channel and further including forming at least one side channel that intersects the main channel, the at least one side channel having a bottom wall and two vertical sidewalls and a cover surface facing the bottom wall, the width of the side channel between the sidewalls and the height of the channel between the bottom wall and cover surface being 1,000 μm or less, and injecting into the side channel at least two parallel streams of liquid and flowing them together in the side channel in adjacent laminar flow, one of the liquids being a solvent which does not affect the surfaces of the bottom wall and the cover surface of the side channel and the other of the liquids

being material that deposits a self-assembled monolayer onto the surfaces of the bottom wall and cover surfaces of the side channel that is non-wettable by the selected liquid, the streams of liquid in the side channel intersecting with and joining the parallel streams of liquid flowing together in the main channel.

41. A method of guiding microfluidic flows of liquid comprising:

(a) providing a micromachined flow guiding structure having a base having a surface and a cover with a surface facing the base surface, the cover surface spaced from the base surface, adjacent facing regions on the base surface and cover surface defining a flow path from a source position to a destination position on the base and cover surfaces, one region on each of the base and cover surfaces formed as a flow guiding stripe wettable by and having a wetting angle of less than 90° with respect to a selected liquid, and a region adjacent to the guiding stripes on the base and cover surfaces being non-wettable by and having a wetting angle of greater than 90° with respect to the selected liquid; and

(b) injecting a stream of the selected liquid onto the flow guiding stripes at a rate to provide laminar flow of the stream between the flow guiding stripes on the base and cover surfaces.

42. The method of Claim 41 wherein the cover surface is spaced from the base surface by 1000 μm or less.

43. The method of Claim 41 including forming two parallel flow guiding stripes on the facing surfaces of the base and cover that are each separated by a region that is not wettable by the selected liquid, and injecting two streams of the selected liquid onto the two parallel flow guiding stripes on the base and cover surfaces at a rate to provide laminar flow of the two streams of liquid and contacting the two streams of liquid without mixing at the interface at which the two streams contact.

44. A method of guiding microfluidic flows of liquid comprising:

(a) providing a micromachined flow guiding structure having a base having a surface and a cover with a surface facing the base surface, the cover surface spaced from the base surface, adjacent facing regions on the base surface and cover surface defining a flow path from a source position to a destination position on the base and cover surfaces, a region on at least one of the base and cover surfaces formed as a flow guiding stripe wettable by and having a wetting angle of less than 90° with respect to a first liquid, and a region adjacent to the guiding stripe being non-wettable by and having a wetting angle of greater than 90° with respect to the selected liquid;

(b) injecting the selected liquid onto the flow guiding stripe;

(c) injecting a second liquid onto the regions adjacent to the guiding stripes and in contact with the first liquid, the second liquid being immiscible with the first liquid and non-wettable with respect to the guiding stripes.

45. The method of Claim 44 wherein the first and second liquids polymerize when in contact to form a polymer layer between the two liquids where they contact.

46. The method of Claim 44 wherein the first liquid is water or a water based solution and the second liquid is an organic liquid immiscible with water.

47. The method of Claim 44 wherein the cover surface is spaced from the base surface by 1000 μm or less.

48. A method of forming a microfluidic flow guiding structure comprising:

(a) forming a bottom wall of a channel in a base;

(b) applying a photopatternable material to the bottom wall; and

(c) photolithographically patterning the photopatternable material to form wettable and non-wettable regions to define a guiding stripe or stripes.

49. The method of Claim 48 wherein the step of photolithographically patterning is carried out by projecting ultraviolet radiation through a mask onto the photopatternable material.

50. The method of Claim 48 further comprising applying a photopatternable material to a surface of a cover, and photolithographically patterning the photopatternable material to form wettable and non-wettable regions to define a guiding stripe or stripes, and mounting the cover onto the base in position so that the flow guiding stripes on the cover and base are adjacent to and face each other.

51. The method of Claim 50 wherein the surfaces of the cover and base having flow guiding stripes thereon are spaced from each other by 1000 μm or less.